# PRESENT WORTH OF ANNUAL CHARGE STUDIES FOR SYSTEM DESIGN

CONTENTS



EXHIBITS



## 1. GENERAL

1.1 This section provides REA Borrowers, consulting engineers, and other interested parties with information for use in the planning, design, and construction of REA Borrowers' telephone systems. It sets forth some of the basic principles involved in the preparation of economic studies for engineering purposes. By the nature of its coverage, it will also expand on the definitions and applications of annual charges provided in TE & CM 218, "Plant Annual Cost Data for System Design Purposes".

1.2 In planning the installation and reinforcement of facilities, there are usually alternatives to accomplishing the same objective. It is the engineer's responsibility to present to the Borrower the design or approach which will achieve the greatest overall economy, and still produce the required results. The correct choice between practicable alternatives requires not only a comparison of the cost of installation and the construction, but also a thorough analysis of pertinent annual charges. Minor plant reinforcement and replacement decisions can sometimes be made on the basis of general determinations. However, individual economic studies must be completed where the application of a general approach will not provide reliable, accurate data on which to base a determination.

1.3 Engineering economy studies determine the relative economy between two or more plans. Annual charge studies and present worth studies are the two major types of economic studies.

1.4 Engineering economy studies do not replace thought and judgement. Neither will they disclose problem conditions or decide on possible solutions to problems. Instead, the studies are only instruments for making objective comparative evaluations. Therefore, the integrity of the study must be assured.

1.5 Annual charges are the yearly expenses associated with owning, operating, and inflicting wear on a telephone system, and also keeping it in functional condition.

1.6 Usually, additions and removals of plant and facilities are made several times during the period under study. The annual charges, consequently vary throughout the period to such a degree that it is impossible to compare the plans without reducing the costs to a common time basis.

1.7 Annual charge studies which have been performed in the past in connection with engineering cost studies for area coverage designs and supplemental loan proposals considered that all of the proposed actions would occur at essentially the same time, and that annual charges would be uniform throughout the entire period being studied. This elementary type of study is inaccurate if the annual charges are not the same each year, or alternative actions will not occur at the same time, or the alternative actions will produce subsequent actions which are significantly different. The Present Worth of Annual Charges (PWAC) type of study is an analytical approach which allows such variations to receive full consideration, and is, therefore, considered essential in performing economic analysis in planning and designing telephone systems.

1.8 Supplemental information on the subject of, "Present Worth of Annual Charges", is included in, "Engineering Economics", by Ollie Smidt, available from Telephony Publishing Corporation, 53 West Jackson Blvd., Chicago, Illinois 60604, and, "Engineering Economy", published by the Commercial Relations Department, Western Electric Co., Inc., P. O. Box 1579, Newark, New Jersey 07102.

## 2. PWAC FACTORS

2.1 First costs and annual costs are the two major factors which will normally be considered in performing PWAC studies.

2.2 First cost is the actual and estimated "one time only" expenditure which will be needed for the construction/installation of plant and equipment. It also includes all associated overhead costs, and other related costs such as modifications, right-of-way procurement, and removals. Stated differently, first costs are those capital expenditures which will be entered on the company's property records.

2.21 In estimating and applying first costs, care must be experienced to use prices which are realistic for the plan being studied. Normally, current prices should be used. However, in studies which extend over a long period, the use of average prices may be advisable providing appropriate adjustments are made to them to reflect price trends or appropriate increases based on reliable advance knowledge. (Re-used material should be priced lower than similar new material.)

2.22 The Installed First Cost (IFC) money required under each plan, both initially and in subsequent years deserves maximum consideration. It is important to remember that, other things being equal, a plan requiring large capital investments has disadvantages as compared with one requiring smaller investments because investments are not flexible.

2.3 Cost of Money, depreciation, income tax, property (ad valorem) tax and maintenance are the normal components of annual costs. In some cases, insurance, traffic, commercial, general and other administrative expenses must also be taken into account. (See Exhibit 1).

2.4 Cost of Money, as used in engineering economy studies, is a composite (weighted) percentage rate which reflects the interest which must be paid on debt capital and the return which must be earned on equity capital.

2.41 Equity capital is the funds derived from sale of stock, or from profits which are reinvested in the system instead of being paid out as dividends, or from the recovery of capital (depreciation) previously invested in the system.

2.42 Return on equity capital is the net income available after the payment of all expenses, including interest on debt capital, and taxes.

2.43 Debt Ratio is the percentage of debt capital compared to total capital. For example, a total of \$800,000 of debt capital and \$200,000 of equity capital produces a debt ratio of \$800,000/(\$800,000 + \$200,000) = 80%.

2.44 Assuming a 5% interest rate on debt capital and 10% return on equity capital, Cost of Money based on the debt ratio derived in 2.43 would be:

| | | |
|---|---|---|
| 5% x 80.0% = | 4.0% | for Debt Capital |
| 10% x 20.0% = | <u>2.0%</u> | for Equity Capital |
| Cost of Money = | 6.0% | |

2.45 A Cost of Money rate less than 6% should not be used in PWAC studies without the prior approval of REA unless the debt interest rate is 2%.

2.5 Depreciation expense provides for depletion in the functional and salvage value of plant. It may be calculated in several ways, two of which are the straight line method and the sinking fund method. Straight line depreciation is most commonly used in the telephone industry as the accounting method of reflecting decreasing value of plant. With this method, the first cost minus the estimated net salvage is pro-rated uniformly over the anticipated service life of the unit.

2.51 Sinking fund depreciation is an adaptation of straight line depreciation to be used in conjunction with straight cost of money in engineering economy work. It considers the declining balance of outstanding capital resulting from capital repayment and obtains the annual depreciation charge by determining what amount per year must be reserved, which at compound interest will provide the first cost less net salvage at the end of the estimated service life. The annuity for a future worth factor (a/f)n is used to calculate the amount of money to be set aside annually. The controlling idea in the sinking fund depreciation approach is that the telephone company will not be reimbursed for the property consumed until consumption has been completed. During the interim, the depreciation charges should be allowed to accumulate interest. In real-life situations, the advisable approach to follow is that funds for depreciation be re-invested in plant thus eliminating the need for an equal amount of borrowed capital. This results in the depreciation reserve effectively earning interest at the same rate as Cost of Money.

2.52 The Sinking Fund Depreciation for a particular plant component or facility, is derived as follows:

(a) Estimate the <u>Service</u> Life

(b) Refer to the "Sinking Fund Factor" table. (Exhibit 2).

(c) Opposite the Estimated Service Life, Years (n), locate the Sinking Fund Depreciation Factor in the appropriate percent column under "Cost of Money".

(d) Convert the factor to percent by multiplying by "100".

Example: If Cost of Money is 8%, the Sinking Fund Depreciation for a building with an estimated 15 years service life remaining is: 0.03683 x 100 = 3.7%

2.53 Sinking fund depreciation is less than straight line depreciation because the payments are reinvested at the Cost of Money where as straight line depreciating payments are placed in the equivalent of a non-interest bearing escrow account.

3. SERVICE LIFE

3.1 Service Life is the anticipated length of time a component will be in service before it is fully depreciated, regardless of its location in the system. It should not be confused with "physical life" which is the time period over which a component continues to function satisfactorily if subjected only to deterioration.

3.11 Deterioration is only one of the factors causing retirement. Among other reasons, plant is also retired because of obsolescence, physical inadequacy, public requirements, aesthetics and functional incompatability.

3.12 When a component of plant is to be retained in service throughout its natural life, the anticipated physical life is the appropriate length of time to consider for depreciation purposes.

3.2 Realistic estimates of the remaining service life of any existing facility which will be retained should be made on the basis of the applications which will be made involving it and other retained facilities.

3.21 A component added to a facility which has a substantially expired service life should be evaluated as having only as much service life remaining as the previously installed facility inasmuch as its usefullness will cease with retirement of the existing facility.

3.3 Sometimes service life is defined by the conditions associated with the plan being studied and the final objective. It may also be predetermined as in the case where it is planned to replace central office equipment after a specific number of years.

3.4 A major source of error in economic study work is often the use of average service lives. Average service life should not be used for a component unless no other information is available.

3.5 Service life cannot be forecast precisely; however, the probable relative lives of the various elements of plant can be estimated with realistic approximations based on experience and projections. Careful attention should be devoted to estimating service life to make certain that it is realistic and representative of good judgement with respect to the plan under study.

3.6 The service lives listed below, and used hereafter in this section, are based on observations and experiences of the REA. However, if appropriate, adjustments should be made for specific individual studies:

(a) COE, Common Control (Electromagnetic) . . . . . . . 30 years
(b) COE, Step-by-Step . . . . . . . . . . . . . . . . . . 25 years
(c) Electronics (Processor Controlled COE, Pair Gain Devices) 20 years
(d) Cable . . . . . . . . . . . . . . . . . . . . . . . . 25 years
(e) Buildings . . . . . . . . . . . . . . . . . . . . . . 30 years

## 4. RETIREMENTS

4.1 Retirements may occur for several reasons such as deterioration, and obsolescence. A large number of retirements also take place because the existing facility has insufficient capacity or is otherwise incompatible because of service demands or other requirements.

4.2 The original cost of the plant to be retired, the depreciation reserve that has been established for it and the net book cost are not relevant to the PWAC study. What is important is the salvage value that can be realized from the retired component, the cost of maintaining it, the taxes that will be required on it if it is retained, and the cost of replacing it. A distinction, however, must be made between whether the retirement will be made at the start of the study period or during the study period.

4.21 When existing plant will be retired under one plan at the start of the study period, and retained under an alternate plan, there are savings in the annual charges for maintenance and ad valorem (property) taxes which favor the plan retiring plant. These are the only components of the annual charge which are affected by retirement, and therefore, the only ones which contribute to any differences in alternate plans.

## 5. SALVAGE VALUE

5.1 Salvage value is the known or estimated value which will be realized from the sale or continued use of removed plant or equipment. As used in engineering economy studies, it refers to the net salvage.

5.2 Net Salvage (or Recovery) value is derived by subtracting from the expected gross salvage the cost of removing the component. If removal of the item under consideration is necessary, the cost of removal must be deducted from the salvage value. If the removal cost exceeds the gross salvage, the net salvage will be a negative amount.

5.3 Salvage value will often be estimated as being equal to the cost of similar new material. However, the salvage value of reusable plant should make allowances for deterioration or obsolescence. If the retired component has potential only as junk, it should be priced accordingly. On the other hand, if it can be repaired or modified to be functionally compatible in the plan being studied, a realistically higher salvage value should be assigned it.

5.4 Salvage and cost of removal are handled in the same manner for existing and proposed plant.

## 6. REARRANGEMENTS

6.1 The method of dealing with rearrangements varies depending on what additional expenses will be encountered in connection with the modification and/or reuse of existing plant. Plant installed during the Planning Period which requires rearrangement is considered existing plant as well as plant which was previously installed.

6.2 If the rearrangement will involve labor and material costs which will be capitalized, there will be an additional annual charge equal to these costs multiplied by the appropriate annual charge factor. If the rearrangement is not of the type to be capitalized, it is considered a maintenance expense in the year in which it occurs. (Refer to Paragraph 9.8.)

6.3 Where re-use is contemplated, the cost of equipment and facilities which is involved should be divided into (a) equipment to be re-used elsewhere, and (b) all other costs.

6.31 The service life assigned to (a) is the total revenue producing life at <u>all</u> locations.

6.32 The service life assigned (b) is the life in the <u>initial location</u> only.

6.33 Consistent with these service lives, salvage is restricted to sale, scrap or trade-in value. This is frequently so small, and will take place so far in the future that, it may be estimated as zero (0) for practical purposes.

6.4 Removal cost is normally cash flow because it is charged to labor. Junk salvage, trade-ins and sales are also actual cash flows. However, when material is removed (salvaged), for re-use and relocated in plant or returned to stock, no real cash flow takes place. Consequently, there may be an appearance of cash flow when, in fact, no cash is involved. Profits are decreased in a year in which rearrangements occur.

## 7. ALTERNATIVES

7.1 Essential to the preparation of PWAC analyses is a recognition and understanding of the major considerations which will influence their outcome and significance. The selection of <u>alternatives</u> is an essential preliminary action.

7.2 It is of the utmost importance that all aspects of the goal to be accomplished be clearly understood before attempts are made to select alternatives for its accomplishment. All relevant information concerning the objective should be compiled, outlined, and afterwards be examined for practicability and feasibility.

7.3 Once the objective has been agreed upon, all alternate plans for its accomplishment should be studied. Sometimes, the number of alternate plans which present themselves as possibilities is so large that a detailed study of each plan would be impractical. In these instances, preliminary evaluations should be made to eliminate those plans which obviously would not withstand comparison. "Rough" cost, coordination and timing appraisals, will permit further elimination.

7.31 The process of reduction of alternative plans should continue as additional data is accumulated and other considerations are made so that the PWAC analysis will involve only those plans which require detailed comparison.

7.4 After a decision is made as to which alternate plans will be studied in detail, one of these plans should be selected as the control plan. Used as the common reference base, the control plan will permit evaluations to be made readily concerning the economic, engineering and other advantages (or disadvantages) of each alternate plan as compared with the control plan or the other alternate plans.

7.41 Reference to the control plan will also tend to insure that all of the alternate plans are equivalent. (See Exhibits 15-17. Plan I is the control plan.)

7.5 The practicability of the alternate plans, both as to construction and operation and the impact on the type of service to be rendered as well as the maintenance of plant are factors which often cannot be expressed easily in terms of annual charges. For example, the numbering flexibility, trunking arrangements, and sophisticated services which common control switching equipment will allow cannot be evaluated in comparing it with step-by-step switching equipment. The capability and adaptability of one plan to meet existing plant conditions and connecting company preferences, and possible contingent developments are also important considerations.

7.6 Every detail of each plan deserving serious consideration should be fully explored. Occasionally, efforts are made to "prove-in" a specific plan. This is economically unwise and inconsistent with the objectivity which should be pursued in making economic selection studies. All efforts and resources should be utilized to find the most economical plan.

## 8. EQUIVALENT PLANS

8.1 In PWAC studies, it is essential that the alternate plans of action be essentially <u>equivalent</u> throughout the study period if the comparison is to be significant. The following guidelines will tend to assure that equivalence will be achieved and maintained.

8.11 The plans must all represent different ways of accomplishing the same objective.

8.12 The plans should provide service over the same period of time.

8.13 The plans should meet the same service demands for each year of the study period.

8.14 Past investments and expenditures should be disregarded if they are common to all plans.

8.15 Revenue is generally a common factor, and can be omitted from the comparisons. However, when revenue is subject to change between alternate plans, it should be included in the study. Any difference in expected revenue should be credited to the plans which generate the increased revenue.

8.16 The end-results must be the same under each alternate plan. In some cases, practical considerations will not permit the study to be carried to a point where all end-results are the same.

8.17 Only the difference between plans is significant. Items of the alternate plans which have the same cost and timing need not be included in the study since identical aspects will not contribute anything to the comparison.

## 9. THE PWAC STUDY

9.1 A PWAC study will consist of a cost comparison of known and estimated expenditures. Intangibles (general factors) which cannot be expressed in terms of money will also need to be compared.

9.2 The outcome of a PWAC analysis will not generally show a change in relationships between widely separated Installed First Costs (IFC) if the plans being compared are essentially similar, especially with respect to annual charge factors and planned installation times. Therefore, PWAC studies need to be made only when definite conclusions are not possible based on broad considerations.

9.3 PWAC studies will normally be made only when one or more feasible alternatives seem practicable for accomplishing the overall objective and definite conclusions are not possible based on broad considerations. Therefore, the initial step in undertaking a comparative economic study is to determine the objectives and then consider what, if any, feasibly practicable alternatives exist.

9.31 All plans should then be described, within the constraints of current and projected conditions, from the standpoints of the types and sequences of actions which will be taken in implementing each plan. The descriptions should cover the type, condition and proposed modification or disposition of existing facilities, as well as the proposed installation of new or transferred facilities.

9.4 The correct preparation of a PWAC analysis involves a Planning Period and a Study Period. (See Exhibit 4).

9.5 The Planning Period extends from the time the study is initially undertaken to the time of the last proposed installation. Stated otherwise, it is the period of time in which plant additions, modifications and removals are designed in alternative ways to meet impending or projected service demands. The length of the planning period should not exceed the number of years in which realistic estimates can be made.

9.6 The Study Period includes the Planning Period, and extends to the time (year) in which investments will no longer be required to obtain equivalence between the alternate plans being compared.

9.62 The Study Period must also be long enough to allow annual charges associated with the last major investment to accumulate to an extent where their effects can be reflected in the study. For instance, if all of the major actions occurred within 10 years, a 20-year study period would be reasonable.

9.63 A widely-held feeling is that the Study Period should be between 15 and 25 years. Any difference in plans beyond 25 years will usually have comparatively negligible effect on the comparisons.

9.64 If the use of a Study Period shorter than 15 years is necessary, a "rule of thumb" which will permit determination of an acceptable length is that the Study Period should be at least 2 to 2½ times as long as the Planning Period.

9.7 The Present Worth of Annual Charge for each element of each plan is derived by the following procedure:

(a) Enter Calendar Year of Proposed Actions

(b) Determine Year (n) of Study Period when the specific action is proposed to occur.

(c) Determine the Installed First Cost (IFC) for the component or facility.

(d) Determine Annual Charge Factor for the component or facility.

(e) Using the "Present Worth Factor" table (Exhibit 5), determine the present worth of an annuity (p/a)n for the Study Period and also each year "n" when action will occur. Obtain the deferred annuity factors by subtraction. (Exhibit 6 shows the deferred annuity factors as developed with Cost of Money at 8%, and a Study Period of 20 years.)

(f) Present Worth of Annual Charges =
IFC x Annual Charge Factor x Deferred Annuity Factor

9.8 The cost associated with a maintenance type rearrangement should be converted into an equivalent annual charge by dividing the cost by the PWAC factor for the years remaining in the Study Period. (Refer to Paragraph 6.2 and Exhibit 10.)

9.9 If one plan requires a much larger investment of capital than another plan, the difference must be considered a major factor, especially in the case of plans involving a large degree of uncertainty.

9.91 Foreseeable economics which may be achieved should outweigh approximately equal present worth economics estimated for a remotely distant date. This is logical because conditions and developments predicted for the near future are more likely to occur than those forecast for the long range.

10. BREAKEVEN POINT

10.1 The breakeven point is the minimum time period--usually expressed in years--when the present worth of annual charges of two alternatives are equal. That is, PW/AC Alternative A, 'n' yrs. = PW/AC Alternative B 'n' yrs.

10.2 If an estimated demand must be met prior to the breakeven point (date), immediate investment will be economical. Conversely, the investment should be postponed if the breakeven point precedes the demand.

10.3 In determining the breakeven point, consideration should be given any cost increases which may be anticipated. (See Exhibits 7 and 8).

10.4 If the equipment or facilities being considered have the same annual charge percentage, computation of the breakeven point can be based solely on installed first costs and the present worths of annuities.

## DERIVATION OF ANNUAL CHARGES
(SAMPLE)

| | | | | C. O. E. | | |
|---|---|---|---|---|---|---|
| | BUILDINGS | CABLE | ELECTRONICS[4] | COMMON CONTROL[5] | S x S (NEW) | S x S (OLD) |
| Cost of Money[1] | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% | 8.0% |
| Maintenance | 1.7 | 1.5 | 5.0 | 3.1 | 3.1 | 4.3 |
| Depreciation, Sinking Fund | .9 (30 yrs) | 1.4 (25 yrs) | 2.2 (20 yrs) | .9 (30 yrs) | 1.4 (25 yrs) | 6.9 (10 yrs)[2] |
| Insurance[3] | .4 | - | .4 | .4 | .4 | .4 |
| Income Tax | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 |
| Property Tax (Ad Valorem) | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| TOTAL | 15.3% | 15.2% | 19.9% | 16.7% | 17.2% | 23.9% |

1 - Includes Net Income (Refer to Paragraph 2.4)
2 - Conservative life estimate for used step-by-step equipment
3 - Insurance rates should be discussed with appropriate insurers to determine realistic values (percentages) to be incorporated in the annual charges.
4 - Processor controlled (digital or analog) COE and pair gain equipment
5 - Electromagnetic type COE

EXHIBIT 1

## SINKING FUND FACTOR

## ANNUITY FOR A FUTURE AMOUNT, (A/F)N

| | COST OF MONEY | | | | |
|---|---|---|---|---|---|
| YEAR(N) | 6% | 7% | 8% | 9% | 10% |
| 1 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 |
| 2 | 0.48544 | 0.48309 | 0.48077 | 0.47847 | 0.47619 |
| 3 | 0.31411 | 0.31105 | 0.30803 | 0.30505 | 0.30211 |
| 4 | 0.22859 | 0.22523 | 0.22192 | 0.21867 | 0.21547 |
| 5 | 0.17740 | 0.17389 | 0.17046 | 0.16709 | 0.16380 |
| 6 | 0.14336 | 0.13980 | 0.13632 | 0.13292 | 0.12961 |
| 7 | 0.11914 | 0.11555 | 0.11207 | 0.10869 | 0.10541 |
| 8 | 0.10104 | 0.09747 | 0.09401 | 0.09067 | 0.08744 |
| 9 | 0.08702 | 0.08349 | 0.08008 | 0.07680 | 0.07364 |
| 10 | 0.07587 | 0.07238 | 0.06903 | 0.06582 | 0.06275 |
| 11 | 0.06679 | 0.06336 | 0.06008 | 0.05695 | 0.05396 |
| 12 | 0.05928 | 0.05590 | 0.05270 | 0.04965 | 0.04676 |
| 13 | 0.05296 | 0.04965 | 0.04652 | 0.04357 | 0.04078 |
| 14 | 0.04758 | 0.04434 | 0.04130 | 0.03843 | 0.03575 |
| 15 | 0.04296 | 0.03979 | 0.03683 | 0.03406 | 0.03147 |
| 16 | 0.03895 | 0.03586 | 0.03298 | 0.03030 | 0.02782 |
| 17 | 0.03544 | 0.03243 | 0.02963 | 0.02705 | 0.02466 |
| 18 | 0.03236 | 0.02941 | 0.02670 | 0.02421 | 0.02193 |
| 19 | 0.02962 | 0.02675 | 0.02413 | 0.02173 | 0.01955 |
| 20 | 0.02718 | 0.02439 | 0.02185 | 0.01955 | 0.01746 |
| 21 | 0.02500 | 0.02229 | 0.01983 | 0.01762 | 0.01562 |
| 22 | 0.02305 | 0.02041 | 0.01803 | 0.01590 | 0.01401 |
| 23 | 0.02128 | 0.01871 | 0.01642 | 0.01438 | 0.01257 |
| 24 | 0.01968 | 0.01719 | 0.01498 | 0.01302 | 0.01130 |
| 25 | 0.01823 | 0.01581 | 0.01368 | 0.01181 | 0.01017 |
| 26 | 0.01690 | 0.01456 | 0.01251 | 0.01072 | 0.00916 |
| 27 | 0.01570 | 0.01343 | 0.01145 | 0.00973 | 0.00826 |
| 28 | 0.01459 | 0.01239 | 0.01049 | 0.00885 | 0.00745 |
| 29 | 0.01358 | 0.01145 | 0.00962 | 0.00806 | 0.00673 |
| 30 | 0.01265 | 0.01059 | 0.00883 | 0.00734 | 0.00608 |
| 31 | 0.01179 | 0.00980 | 0.00811 | 0.00669 | 0.00550 |
| 32 | 0.01100 | 0.00907 | 0.00745 | 0.00610 | 0.00497 |
| 33 | 0.01027 | 0.00841 | 0.00685 | 0.00556 | 0.00450 |
| 34 | 0.00960 | 0.00780 | 0.00630 | 0.00508 | 0.00407 |
| 35 | 0.00897 | 0.00723 | 0.00580 | 0.00464 | 0.00369 |
| 40 | 0.00646 | 0.00501 | 0.00386 | 0.00296 | 0.00226 |
| 45 | 0.00470 | 0.00350 | 0.00259 | 0.00190 | 0.00139 |
| 50 | 0.00344 | 0.00246 | 0.00174 | 0.00123 | 0.00086 |
| 55 | 0.00254 | 0.00174 | 0.00118 | 0.00079 | 0.00053 |
| 60 | 0.00188 | 0.00123 | 0.00080 | 0.00051 | 0.00033 |

Exhibit 2(a)

SINKING FUND FACTOR

ANNUITY FOR A FUTURE AMOUNT, (A/F)N

| | COST OF MONEY | | | | |
|---|---|---|---|---|---|
| YEAR (N) | 11% | 12% | 13% | 14% | 15% |
| 1 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 |
| 2 | 0.47393 | 0.47170 | 0.46948 | 0.46729 | 0.46412 |
| 3 | 0.29921 | 0.29635 | 0.29352 | 0.29073 | 0.28798 |
| 4 | 0.21233 | 0.20923 | 0.20619 | 0.20320 | 0.20027 |
| 5 | 0.16057 | 0.15741 | 0.15431 | 0.15128 | 0.14832 |
| 6 | 0.12638 | 0.12323 | 0.12015 | 0.11715 | 0.11424 |
| 7 | 0.10222 | 0.09912 | 0.09611 | 0.09319 | 0.09036 |
| 8 | 0.08432 | 0.08130 | 0.07839 | 0.07557 | 0.07285 |
| 9 | 0.07060 | 0.06768 | 0.06487 | 0.06217 | 0.05957 |
| 10 | 0.05980 | 0.05698 | 0.05429 | 0.05171 | 0.04925 |
| 11 | 0.05112 | 0.04842 | 0.04584 | 0.04339 | 0.04107 |
| 12 | 0.04403 | 0.04144 | 0.03899 | 0.03667 | 0.03448 |
| 13 | 0.03815 | 0.03568 | 0.03335 | 0.03116 | 0.02911 |
| 14 | 0.03323 | 0.03087 | 0.02867 | 0.02661 | 0.02469 |
| 15 | 0.02907 | 0.02682 | 0.02474 | 0.02281 | 0.02102 |
| 16 | 0.02552 | 0.02339 | 0.02143 | 0.01962 | 0.01795 |
| 17 | 0.02247 | 0.02046 | 0.01861 | 0.01692 | 0.01537 |
| 18 | 0.01984 | 0.01794 | 0.01620 | 0.01462 | 0.01319 |
| 19 | 0.01756 | 0.01576 | 0.01413 | 0.01266 | 0.01134 |
| 20 | 0.01558 | 0.01388 | 0.01235 | 0.01099 | 0.00976 |
| 21 | 0.01384 | 0.01224 | 0.01081 | 0.00954 | 0.00842 |
| 22 | 0.01231 | 0.01081 | 0.00948 | 0.00830 | 0.00727 |
| 23 | 0.01097 | 0.00956 | 0.00832 | 0.00723 | 0.00628 |
| 24 | 0.00979 | 0.00846 | 0.00731 | 0.00630 | 0.00543 |
| 25 | 0.00874 | 0.00750 | 0.00643 | 0.00550 | 0.00470 |
| 26 | 0.00781 | 0.00665 | 0.00565 | 0.00480 | 0.00407 |
| 27 | 0.00699 | 0.00590 | 0.00498 | 0.00419 | 0.00353 |
| 28 | 0.00626 | 0.00524 | 0.00439 | 0.00366 | 0.00306 |
| 29 | 0.00561 | 0.00466 | 0.00387 | 0.00320 | 0.00265 |
| 30 | 0.00502 | 0.00414 | 0.00341 | 0.00280 | 0.00230 |
| 31 | 0.00451 | 0.00369 | 0.00301 | 0.00245 | 0.00200 |
| 32 | 0.00404 | 0.00328 | 0.00266 | 0.00215 | 0.00173 |
| 33 | 0.00363 | 0.00292 | 0.00234 | 0.00188 | 0.00150 |
| 34 | 0.00326 | 0.00260 | 0.00207 | 0.00165 | 0.00131 |
| 35 | 0.00293 | 0.00232 | 0.00183 | 0.00144 | 0.00113 |
| 40 | 0.00172 | 0.00130 | 0.00099 | 0.00075 | 0.00056 |
| 45 | 0.00101 | 0.00074 | 0.00053 | 0.00039 | 0.00028 |
| 50 | 0.00060 | 0.00042 | 0.00029 | 0.00020 | 0.00014 |
| 55 | 0.00035 | 0.00024 | 0.00016 | 0.00010 | 0.00007 |
| 60 | 0.00021 | 0.00013 | 0.00009 | 0.00005 | 0.00003 |

Exhibit 2(b)

## COMPARISON OF STRAIGHT LINE AND SINKING FUND DEPRECIATION

EXAMPLE 1

$100,000 Building with Estimated 30 year Service Life; Estimated Net Salvage = 6% ($6,000); Cost of Money: 8%

SOLUTION:

Straight Line Depreciation = $\frac{100\% - 6\%}{30} = \frac{94\%}{30} = 3.133\%$

Annual Depreciation Expense = 3.133% ($100,000) = $3,133

PROOF:

30 Year Straight Line Depreciation Reserve = (30 x $3,133) + $6,000

" " " " " " " = $99,990 (Approx. $100,000)

------------------------------------vs------------------------------------

SOLUTION:

Sinking Fund Depreciation = $(100\% - 6\%)\ (a/f)^{8\%}_{30}$

" " " " = 94% (0.00883) = .0083

Annual Depreciation Expense = 0.0083 ($100,000)

" " " " =$830.00

PROOF:

30 Year Sinking Fund = ($830 x Future Worth of 30 Year Annuity) + $6,000
Depreciation Reserve

" " " = $(\$830 \times (f/a)^{8\%}_{30}) + \$6,000$

" " " = ($830 x 113.283) + $6,000

" " " = $100,025 (Approx. $100,000)

EXHIBIT 3

DIAGRAM OF PLANNING PERIOD AND STUDY PERIOD

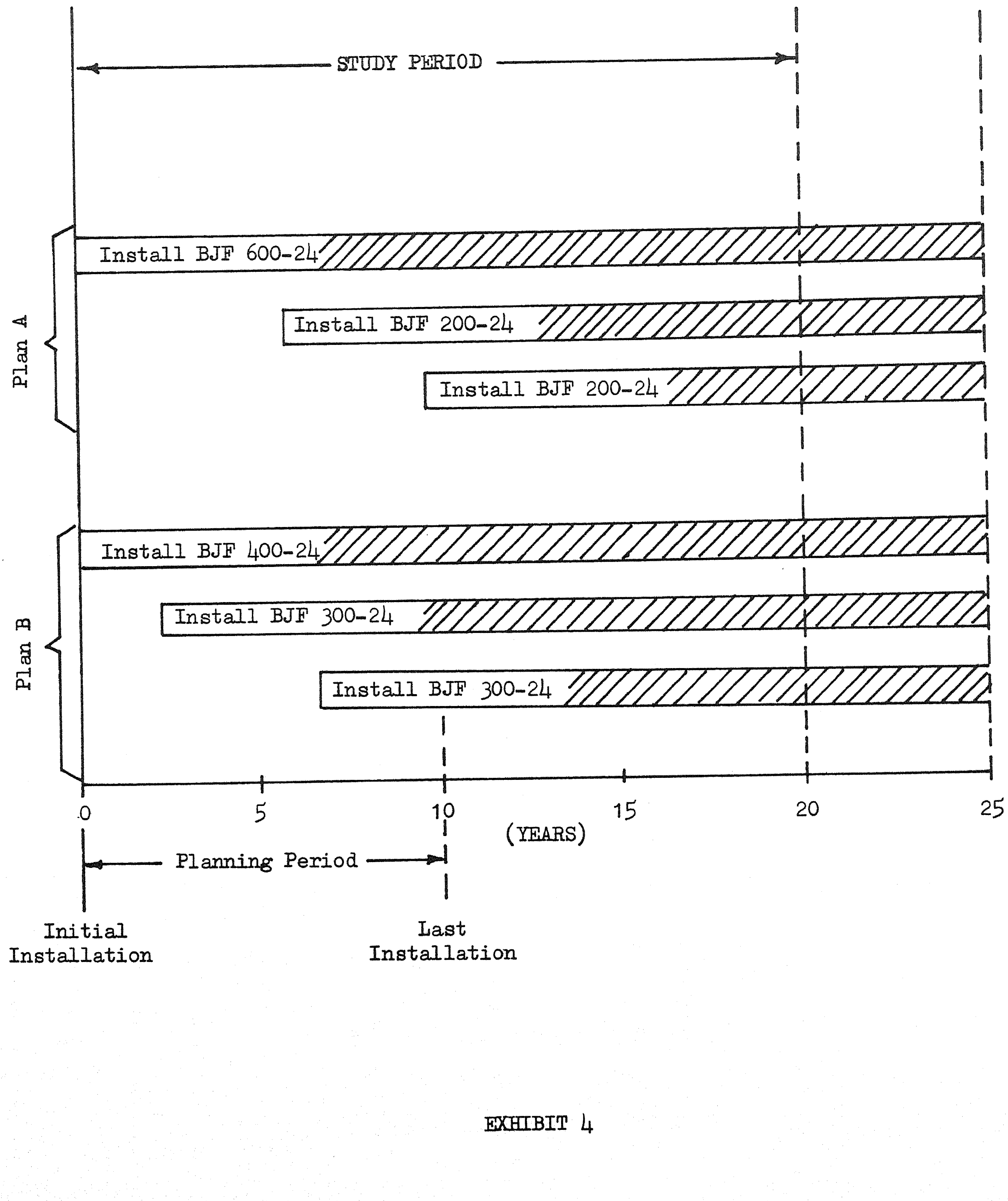



EXHIBIT 4

PRESENT WORTH FACTOR

PRESENT WORTH OF AN ANNUITY, (P/A)N

| | COST OF MONEY | | | | |
|---|---|---|---|---|---|
| YEAR (N) | 6% | 7% | 8% | 9% | 10% |
| 1 | 0.943 | 0.935 | 0.926 | 0.917 | 0.909 |
| 2 | 1.833 | 1.808 | 1.783 | 1.759 | 1.736 |
| 3 | 2.673 | 2.624 | 2.577 | 2.531 | 2.487 |
| 4 | 3.465 | 3.387 | 3.312 | 3.240 | 3.170 |
| 5 | 4.212 | 4.100 | 3.993 | 3.890 | 3.791 |
| 6 | 4.917 | 4.767 | 4.623 | 4.486 | 4.355 |
| 7 | 5.582 | 5.389 | 5.206 | 5.033 | 4.868 |
| 8 | 6.210 | 5.971 | 5.747 | 5.535 | 5.335 |
| 9 | 6.802 | 6.515 | 6.247 | 5.995 | 5.759 |
| 10 | 7.360 | 7.024 | 6.710 | 6.418 | 6.145 |
| 11 | 7.887 | 7.499 | 7.139 | 6.805 | 6.495 |
| 12 | 8.384 | 7.943 | 7.536 | 7.161 | 6.814 |
| 13 | 8.853 | 8.358 | 7.904 | 7.487 | 7.103 |
| 14 | 9.295 | 8.745 | 8.244 | 7.786 | 7.367 |
| 15 | 9.712 | 9.108 | 8.559 | 8.061 | 7.606 |
| 16 | 10.106 | 9.447 | 8.851 | 8.313 | 7.824 |
| 17 | 10.477 | 9.763 | 9.122 | 8.544 | 8.022 |
| 18 | 10.828 | 10.059 | 9.372 | 8.756 | 8.201 |
| 19 | 11.158 | 10.336 | 9.604 | 8.950 | 8.365 |
| 20 | 11.470 | 10.594 | 9.818 | 9.129 | 8.514 |
| 21 | 11.764 | 10.836 | 10.017 | 9.292 | 8.649 |
| 22 | 12.042 | 11.061 | 10.201 | 9.442 | 8.772 |
| 23 | 12.303 | 11.272 | 10.371 | 9.580 | 8.883 |
| 24 | 12.550 | 11.469 | 10.529 | 9.707 | 8.985 |
| 25 | 12.783 | 11.654 | 10.675 | 9.823 | 9.077 |
| 26 | 13.003 | 11.826 | 10.810 | 9.929 | 9.161 |
| 27 | 13.211 | 11.987 | 10.935 | 10.027 | 9.237 |
| 28 | 13.406 | 12.137 | 11.051 | 10.116 | 9.307 |
| 29 | 13.591 | 12.278 | 11.158 | 10.198 | 9.370 |
| 30 | 13.765 | 12.409 | 11.258 | 10.274 | 9.427 |
| 31 | 13.929 | 12.532 | 11.350 | 10.343 | 9.479 |
| 32 | 14.084 | 12.647 | 11.435 | 10.406 | 9.526 |
| 33 | 14.230 | 12.754 | 11.514 | 10.464 | 9.569 |
| 34 | 14.368 | 12.854 | 11.587 | 10.518 | 9.609 |
| 35 | 14.498 | 12.948 | 11.655 | 10.567 | 9.644 |
| 40 | 15.046 | 13.332 | 11.925 | 10.757 | 9.779 |
| 45 | 15.456 | 13.606 | 12.108 | 10.881 | 9.863 |
| 50 | 15.762 | 13.801 | 12.233 | 10.962 | 9.915 |
| 55 | 15.991 | 13.940 | 12.319 | 11.014 | 9.947 |
| 60 | 16.161 | 14.039 | 12.377 | 11.048 | 9.967 |

Exhibit 5(a)

PRESENT WORTH FACTOR

PRESENT WORTH OF AN ANNUITY, (P/A)N

| | COST OF MONEY | | | | |
|---|---|---|---|---|---|
| YEAR (N) | 11% | 12% | 13% | 14% | 15% |
| 1 | 0.901 | 0.893 | 0.885 | 0.877 | 0.870 |
| 2 | 1.713 | 1.690 | 1.668 | 1.647 | 1.626 |
| 3 | 2.444 | 2.402 | 2.361 | 2.322 | 2.283 |
| 4 | 3.102 | 3.037 | 2.974 | 2.914 | 2.855 |
| 5 | 3.696 | 3.605 | 3.517 | 3.433 | 3.352 |
| 6 | 4.231 | 4.111 | 3.998 | 3.889 | 3.784 |
| 7 | 4.712 | 4.564 | 4.423 | 4.288 | 4.160 |
| 8 | 5.146 | 4.968 | 4.799 | 4.639 | 4.487 |
| 9 | 5.537 | 5.328 | 5.132 | 4.946 | 4.772 |
| 10 | 5.889 | 5.650 | 5.426 | 5.216 | 5.019 |
| 11 | 6.207 | 5.938 | 5.687 | 5.453 | 5.234 |
| 12 | 6.492 | 6.194 | 5.918 | 5.660 | 5.421 |
| 13 | 6.750 | 6.424 | 6.122 | 5.842 | 5.583 |
| 14 | 6.982 | 6.628 | 6.302 | 6.002 | 5.724 |
| 15 | 7.191 | 6.811 | 6.462 | 6.142 | 5.847 |
| 16 | 7.379 | 6.974 | 6.604 | 6.265 | 5.954 |
| 17 | 7.549 | 7.120 | 6.729 | 6.373 | 6.047 |
| 18 | 7.702 | 7.250 | 6.840 | 6.467 | 6.128 |
| 19 | 7.839 | 7.366 | 6.938 | 6.550 | 6.198 |
| 20 | 7.963 | 7.469 | 7.025 | 6.623 | 6.259 |
| 21 | 8.075 | 7.562 | 7.102 | 6.687 | 6.312 |
| 22 | 8.176 | 7.645 | 7.170 | 6.743 | 6.359 |
| 23 | 8.266 | 7.718 | 7.230 | 6.792 | 6.399 |
| 24 | 8.348 | 7.784 | 7.283 | 6.835 | 6.434 |
| 25 | 8.422 | 7.843 | 7.330 | 6.873 | 6.464 |
| 26 | 8.488 | 7.896 | 7.372 | 6.906 | 6.491 |
| 27 | 8.548 | 7.943 | 7.409 | 6.935 | 6.514 |
| 28 | 8.602 | 7.984 | 7.441 | 6.961 | 6.534 |
| 29 | 8.650 | 8.022 | 7.470 | 6.983 | 6.551 |
| 30 | 8.694 | 8.055 | 7.496 | 7.003 | 6.566 |
| 31 | 8.733 | 8.085 | 7.518 | 7.020 | 6.579 |
| 32 | 8.769 | 8.112 | 7.538 | 7.035 | 6.591 |
| 33 | 8.801 | 8.135 | 7.556 | 7.048 | 6.600 |
| 34 | 8.829 | 8.157 | 7.572 | 7.060 | 6.609 |
| 35 | 8.855 | 8.176 | 7.586 | 7.070 | 6.617 |
| 40 | 8.951 | 8.244 | 7.634 | 7.105 | 6.642 |
| 45 | 9.008 | 8.283 | 7.661 | 7.123 | 6.654 |
| 50 | 9.042 | 8.305 | 7.675 | 7.133 | 6.661 |
| 55 | 9.062 | 8.317 | 7.683 | 7.138 | 6.664 |
| 60 | 9.074 | 8.324 | 7.687 | 7.140 | 6.665 |

Exhibit 5(b)

# CALCULATION OF DEFERRED ANNUITY

Develop factors for a deferred annuity for an 8% Cost of Money and a 20 year planning period.

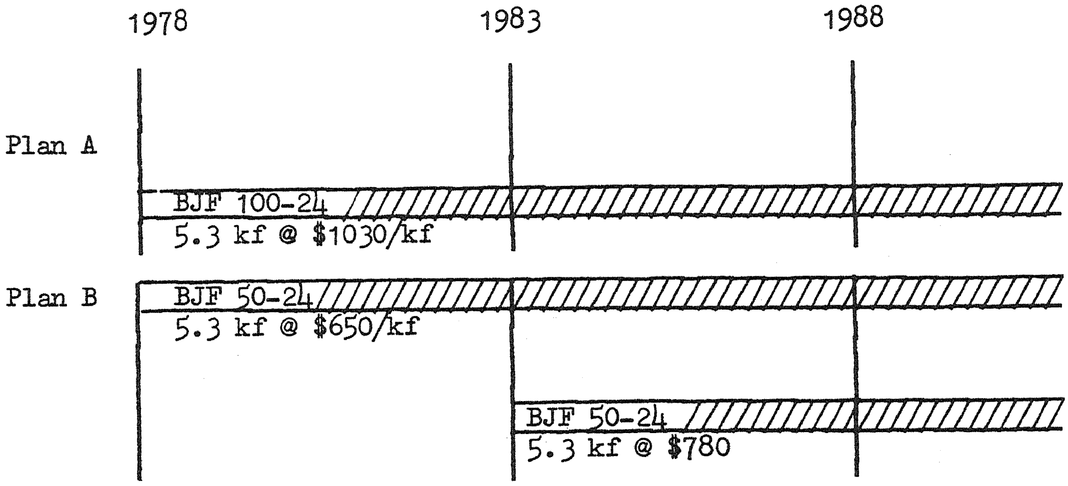
| $n$ | $(p/a)^{8\%}_{20\text{ yrs.}}$ | $(p/a)^{8\%}_{n}$ | $(p/a)^{8\%}_{20} - (p/a)^{8\%}_{n}$ |
|---|---|---|---|
| 0 | 9.818 | 0.000 | 9.818 |
| 1 | 9.818 | 0.926 | 8.892 |
| 2 | 9.818 | 1.783 | 8.035 |
| 3 | 9.818 | 2.577 | 7.241 |
| 4 | 9.818 | 3.312 | 6.506 |
| 5 | 9.818 | 3.993 | 5.825 |
| 6 | 9.818 | 4.623 | 5.195 |
| 7 | 9.818 | 5.206 | 4.612 |
| 8 | 9.818 | 5.747 | 4.071 |
| 9 | 9.818 | 6.247 | 3.571 |
| 10 | 9.818 | 6.710 | 3.108 |
| 11 | 9.818 | 7.139 | 2.679 |
| 12 | 9.818 | 7.536 | 2.282 |
| 13 | 9.818 | 7.904 | 1.914 |
| 14 | 9.818 | 8.244 | 1.574 |
| 15 | 9.818 | 8.559 | 1.259 |
| 16 | 9.818 | 8.851 | 0.967 |
| 17 | 9.818 | 9.122 | 0.696 |
| 18 | 9.818 | 9.372 | 0.446 |
| 19 | 9.818 | 9.604 | 0.214 |
| 20 | 9.818 | 9.818 | 0.000 |

EXHIBIT 6

## DETERMINATION OF CABLE SIZE BASED ON PWAC

EXAMPLE 2

A determination must be made whether (A) BJF 100-24 will be installed, or (B) a BJF 50-24 will be installed initially to be reinforced in 5 years with another BJF 50-24. The cost of cable is expected to increase 20% during the 5-year interim (1978-83). Assume Cost of Money =8%; Service Life of Cable = 25 years; Study Period = 25 years.




PRESENT WORTH OF ANNUAL CHARGES:
IFC x Annual Charge x $(p/a)^{8\%}_{25}$

PLAN A:

Yr. '0': (5.3) x ($1030) x 0.152 x (10.675) = $8,858

PLAN B:

Yr. '0': (5.3) x ($650) x 0.152 x (10.675) = $5,590
Yr. '5': (5.3) x ($780) x 0.152 (10.675 - 3.993) = 4,199
$9,789

Based on PW/AC, The BJF 100-24 should be installed.

EXHIBIT 7

## CALCULATION OF BREAK-EVEN POINT

EXAMPLE 3

The results of Example 2 show that it is economically advantageous to install a BJF 100-24 instead of a BJF 50-24 initially with reinforcement planned in 5 years with another BJF 50-24.

What is the breakeven point beyond which the installation of two BJF 50-24 cables would be more economical than one BJF 100-24 installed initially?

Solution:

$$IFC_{50} \times (p/a)_{25}^{8\%} + 1.20\ IFC_{50} \left[ (p/a)_{25}^{8\%} - (p/a)_{n}^{8\%} \right] = IFC_{100} \times (p/a)_{25}^{8\%}$$

$$-1.20\ IFC_{50}\ (p/a)_{n}^{8\%} = (p/a)_{25}^{8\%}\ (IFC_{100} - 2.20\ IFC_{50})$$

$$(p/a)_{n}^{8\%} = \frac{10.675\ (\$1030 - 2.2 \times \$650)}{-1.2\ (\$650)}$$

$$= 5.474 \text{ @ } n = 7 \text{ yrs. } +$$

Use 8 yrs. (Break-Even Point)

EXHIBIT 8

## ANALYSES OF ALTERNATE PLANS BASED ON PWAC

Example 4

Growth at a point 40 KF from the central office is estimated to be a uniform 10 feeder pairs per year for the next 10 years. Existing facilities consist of 50 loaded physical feeder pairs. For reinforcement, consider 25, 50, and 100 pair increments of cable reinforcement, also electronic concentrators for permanent or temporary use. Assume the Study Period will be 20 years which is the estimated service life of electronic facilities. Cost of Money is assumed to be 8%, and a yearly inflation rate of 5% is estimated for the Planning Period.

| Year (n) | Circuits Required | Plan 1 Cable (Pairs) | Plan 2 Cable (Pairs) | Plan 3 Electronic Concentrator Lines |
|---|---|---|---|---|
| 0 | 60 | 25 | 50 | 24 (68)* |
| 1 | 70 | - | - | 12 (74) |
| 2 | 80 | 25 | - | 12 (86) |
| 3 | 90 | - | - | 12 (92) |
| 4 | 100 | - | - | 12 (104) |
| 5 | 110 | 25 | 50 | 100 pair cable (150) |
| 6 | 120 | - | - | |
| 7 | 130 | 25 | - | |
| 8 | 140 | - | - | |
| 9 | 150** | - | - | |
| 10 | 160 | 25 | 50 | 24 |

*Adding a 24-line concentrator gives a net gain of only 18 lines.

**The plans are equivalent at the end of 9 years so the planning period should end in the seventh year (the year of the last placement) or the planning period should find another equivalence beyond the tenth year.

### SUMMARY OF RESULTS

| | Present Worth of Annual Changes | Installed First Cost |
|---|---|---|
| Plan 3 - Install 3 concentrators, then 100 pr. cables | $77,990 | $58,436 |
| Plan 2 - Install 2 - 50 pr. cables | 85,245 | 59,200 |
| Plan 1 - Install 4 - 25 pr. cables | 104,057 | 80,400 |

EXHIBIT 9

EXAMPLE 4

PLAN:________ DESCRIPTION: ______________________________

| YEAR: STUDY | YEAR: DEFERRED (n) | ACTIVITY | INSTALLED FIRST COST (IFC) | ANNUAL CHARGES FACTOR | $[(p/a)^{8\%}_{20} - (p/a)^{8\%}_{n}]$ | PRESENT WORTH OF ANNUAL CHARGES |
|---|---|---|---|---|---|---|
| | | Plan 1 | | | | |
| 1977 | 0 | Install BJF 25-24: 40 KF @ $420/KF | $ 16,800 | .19 | 9.818 | $ 31,339 |
| 1979 | 2 | Install BJF 25-24: 40 KF @ $463/KF | 18,520 | .19 | 8.035 | 28,274 |
| 1982 | 5 | Install BJF 25-24: 40 KF @ $536/KF | 21,440 | .19 | 5.825 | 23,729 |
| 1984 | 7 | Install BJF 25-24: 40 KF @ $591/KF | 23,640 | .19 | 4.612 | 20,715 |
| | | TOTAL | $ 80,400 | | | $ 104,057 |
| | | Plan 2 | | | | |
| 1977 | 0 | Install BJF 50-24: 40 KF @ $650/KF | $ 26,000 | .19 | 9.818 | $ 48,501 |
| 1982 | 5 | Install BJF 50-24: 40 KF @ $830/KF | 33,200 | .19 | 5.825 | 36,744 |
| | | TOTAL | $ 59,200 | | | $ 85,245 |
| | | Plan 3 | | | | |
| 1977 | 0 | Install 24-line concentrator | $ 6,300 | .23 | 9.818 | $ 14,226 |
| 1978 | 1 | Install 24-line concentrator; equip. 12-lines | 5,040 | .23 | 8.892 | 10,308 |
| 1979 | 2 | Add second 12 concentrator lines | 1,654 | .23 | 8.035 | 3,057 |
| 1980 | 3 | Install 24-line concentrator; equip. 12-lines | 5,558 | .23 | 7.241 | 9,256 |
| 1981 | 4 | Add second 12 concentrator lines | 1,824 | .23 | 6.506 | 2,729 |
| 1982 | 5 | Install BJF 100-24: 40 KF @ $1314/KF | 52,560 | .19 | 5.825 | 58,171 |
| 1982 | 5 | Remove 3 - 24-line concentrators* | 500 | 1/8.559 | 5.825 | 339 |
| 1982 | 5 | Recover 3 - 24-line concentrators** | (15,000) | .23 | 5.825 | (20,096) |
| | | TOTAL | $ 58,436 | | | $ 77,990 |

*Assumes subscriber end only is to be removed. Removal cost is converted to annual charge by taking the reciprocal of the PW/AC factor for the remaining years of the study period.

**Removed concentrators are assumed to be reusable in the exchange at depreciated values.

EXHIBIT 10

ANALYSES OF ALTERNATE PLANS BASED ON PWAC

## ANALYSES OF ALTERNATE PLANS BASED ON PWAC

EXAMPLE 5

Alpha office (500 lines) and Omega office (550 lines) have estimated 5-year requirements of 900 lines and 750 lines, respectively. Both offices are step-by-step, and have been in operation 14 years. Extended area service currently exists between the two exchanges over 7.3 miles of physical trunks.

Plan I proposes the consolidation of Alpha and Omega to permit their replacement with a 1700 line common control office at Alpha. Plan II would result in both Alpha and Omega being converted to common control operation. Another alternative being considered is, Plan III, the installation of common control equipment at Alpha only, and transfer of its step-by-step equipment to expand the Omega office. (Omega would also be converted to common control operation later, i.e., when the capacity of the step-by-step lines is exceeded.) A new building will be required at Alpha under all plans, whereas, only an addition to the Omega building will be necessary under Plans II and III.

Cost of Money is assumed to be 8%, and a 20-year Study Period has been selected. An annual inflation rate of 5% is estimated for the Planning Period. Based on PWAC, which plan should be selected? (See Exhibits 12-17)

### SUMMARY OF RESULTS

| | Installed First Cost | Present Worth of Annual Charges |
|---|---|---|
| Plan II | $994,400 | $1,473,844 |
| Plan III | 1,179,750 | 1,519,271 |
| Plan I | 1,798,300 | 2,353,291 |

EXHIBIT 11

ANALYSES OF ALTERNATE PLANS BASED ON PWAC

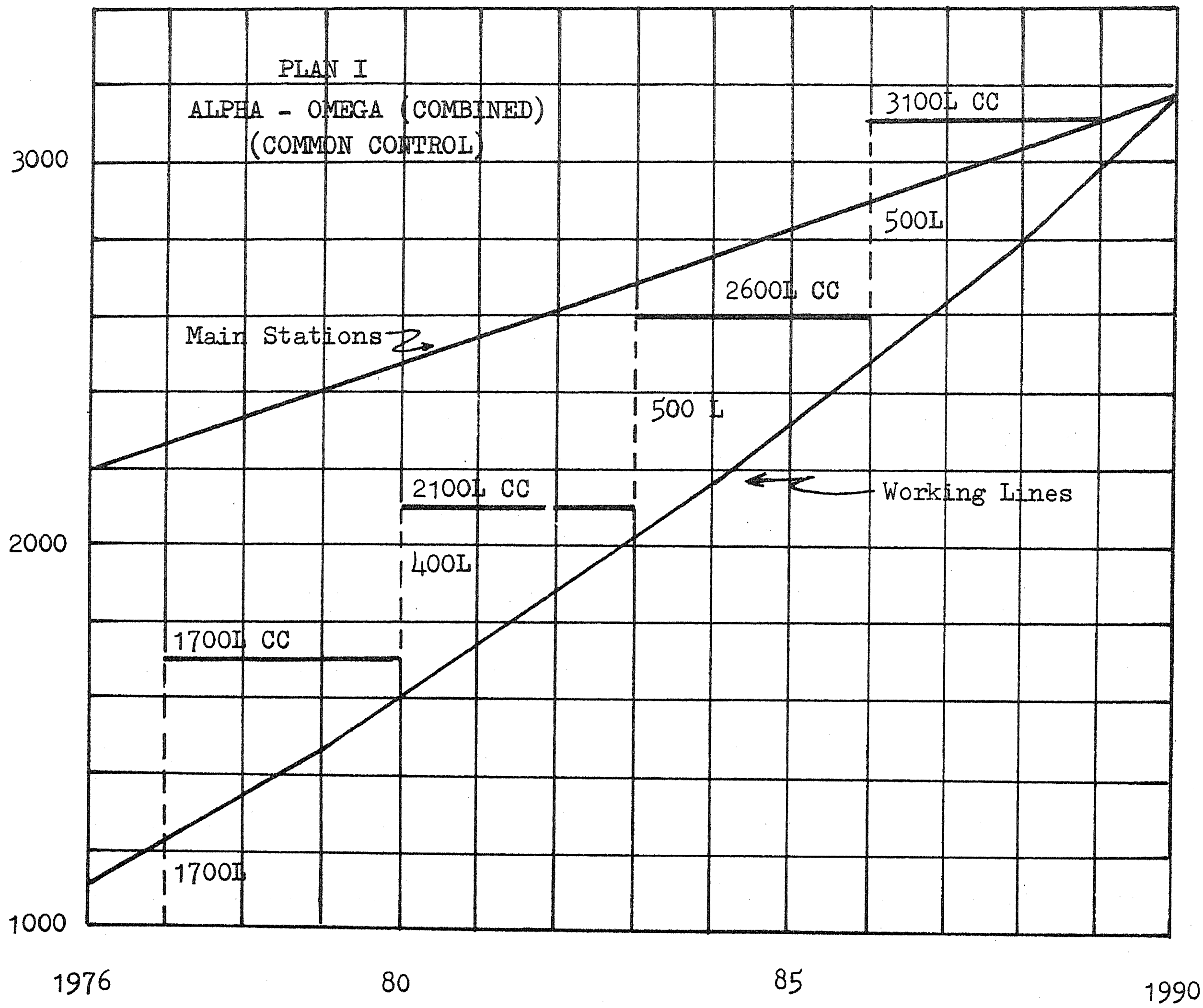



EXHIBIT 12

ANALYSES OF ALTERNATE PLANS BASED ON PWAC

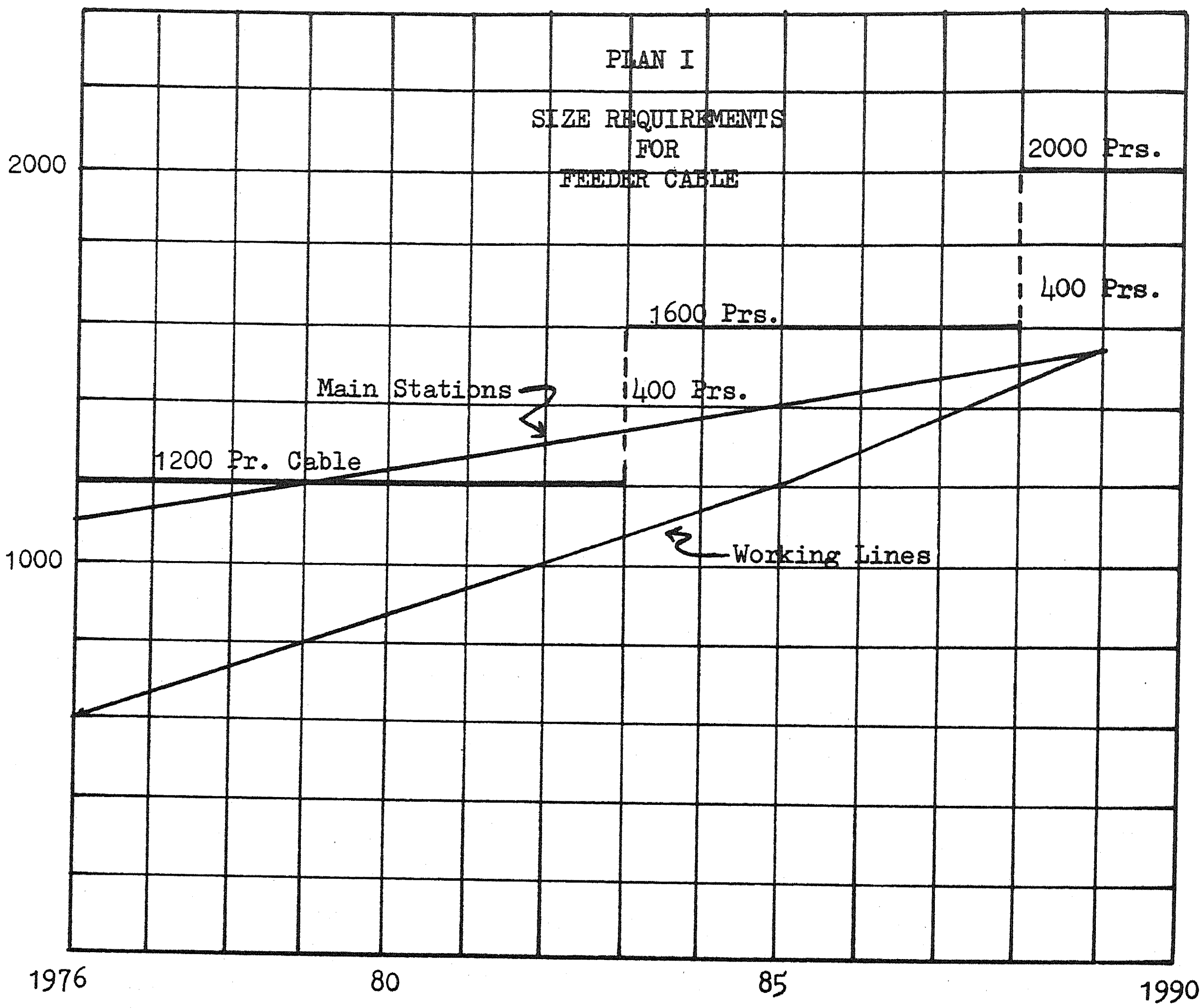
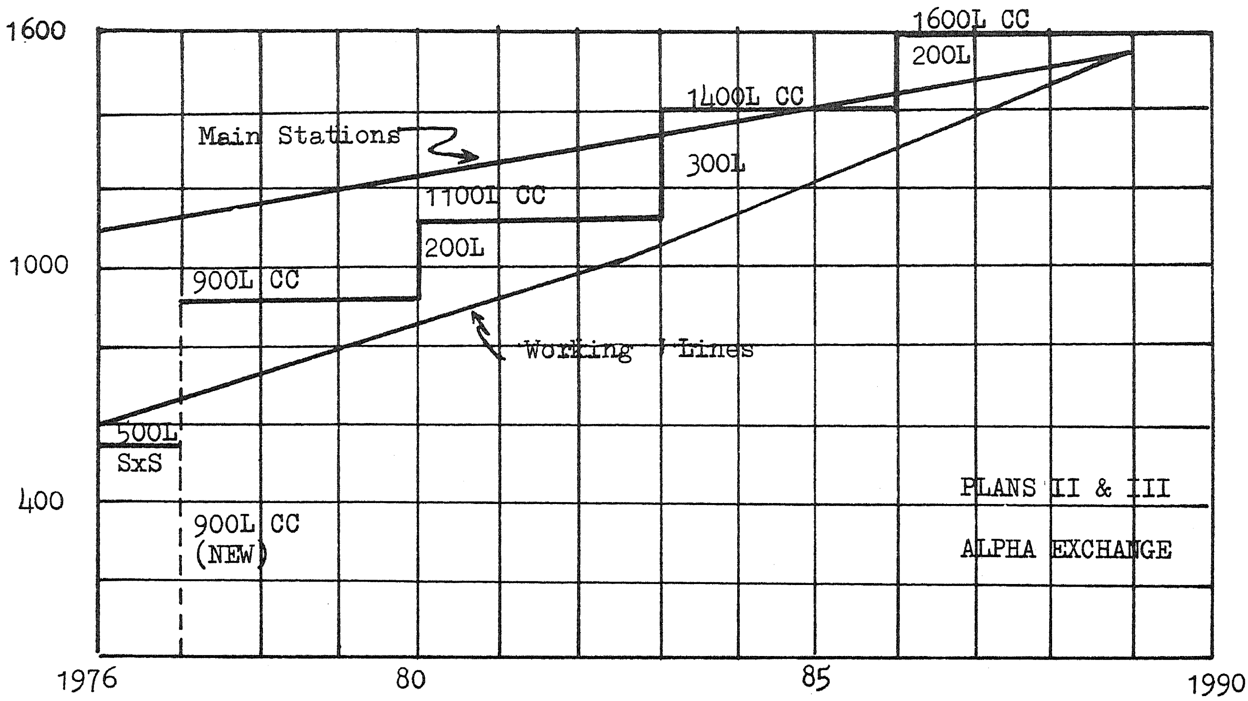
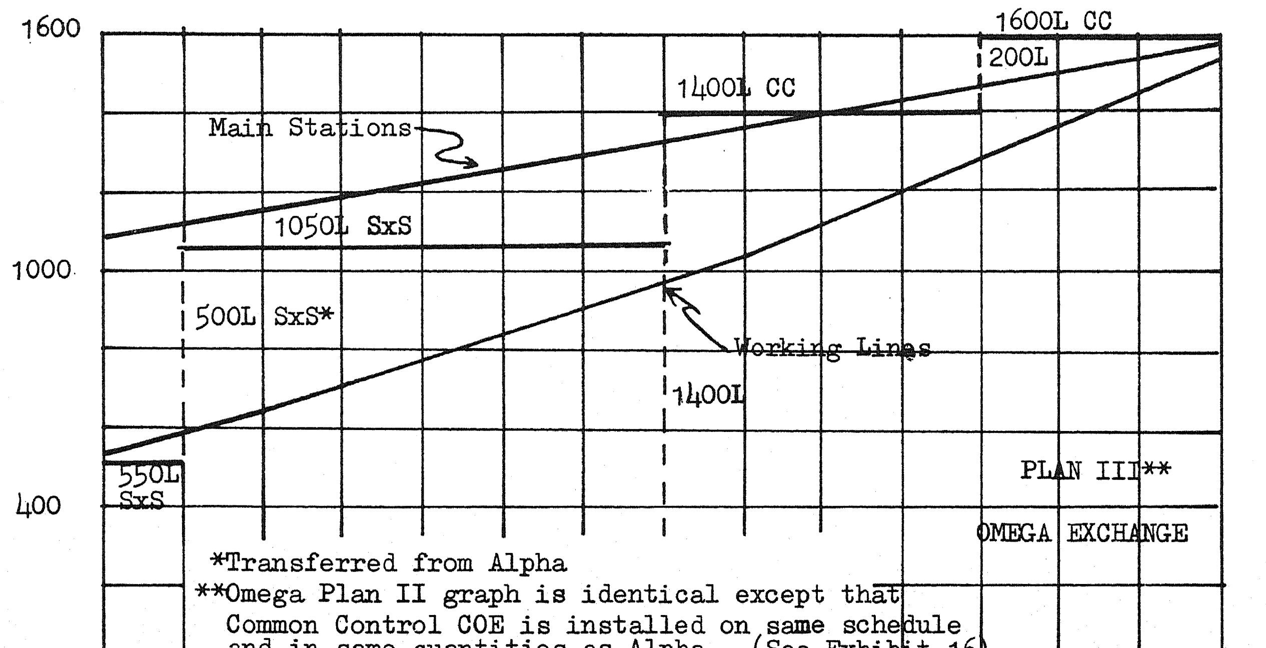



EXHIBIT 13

ANALYSES OF ALTERNATE PLANS BASED ON PWAC




*Transferred from Alpha

**Omega Plan II graph is identical except that Common Control COE is installed on same schedule and in same quantities as Alpha. (See Exhibit 16)

EXHIBIT 14

PLAN: I DESCRIPTION: ALPHA AND OMEGA COMBINED, Common Control

| YEAR | | ACTIVITY | INSTALLED FIRST COST (IFC) | ANNUAL CHARGES FACTOR | $\left[\frac{(p/a)^{8\%}_{20}}{(p/a)^{8\%}_{n}}\right]$ | PRESENT WORTH OF ANNUAL CHARGES |
|---|---|---|---|---|---|---|
| STUDY | DEFERRED (n) | | | | | |
| 1978 | 0 | 1700 Line, Common Control, 153T @ $250/Line | $ 425,000 | .212 | 9.818 | $ 884,602 |
| | 0 | ATT | 35,000 | .212 | 9.818 | 72,850 |
| | 0 | Building Addition: | 45,000 | .173 | 9.818 | 76,433 |
| | 0 | Cable: 34.0KF BJF 1200-24 @ $8,000/KF | 272,000 | .187 | 9.818 | 499,382 |
| | 0 | ATT Revenue: $9,300 | - | - | 9.818 | (91,000) |
| | 0 | S x S Retirement: $200,000 | - | .06* | 9.818 | (117,816) |
| | 0 | 1050 Lines S x S Net Salvage @ $30/Line** | (31,500) | | | |
| | 0 | 900 LE & VFR @ $60.00 ea. (CMO) | 54,000 | .232 | 9.818 | 123,000 |
| 1980 | 3 | 400 Lines @ $290/Line | 116,000 | .212 | 7.241 | 178,070 |
| | 3 | 200 LE & VFR (CMO) | 13,800 | .232 | 7.241 | 23,183 |
| 1983 | 6 | 34.0KF BJF 400-24 @ $5360/KF | 167,000 | .187 | 5.195 | 162,234 |
| | 6 | 500 Lines @ $335.00/Line | 182,240 | .212 | 5.195 | 200,708 |
| | 6 | 200 LE & VFR (CMO) @ $80.00 ea. | 16,000 | .232 | 5.195 | 19,283 |
| 1985 | 8 | 200 LE & VFR (CMO) @ $89.00 ea. | 17,800 | .232 | 4.071 | 16,812 |
| 1986 | 9 | 600 Lines @ $388/Line | 232,300 | .212 | 3.571 | 176,241 |
| 1988 | 11 | 200 LE & VFR (CMO) @ $103 | 20,600 | .232 | 2.679 | 12,803 |
| | 11 | 34.0 KF BJF 400-24 @ $6,840 | 232,560 | .187 | 2.679 | 116,506 |
| | | | $1,798,300 | | | $ 2,353,291 |

*Maintenance & Ad Valorem Taxes

**If system includes S x S offices other than those being studied, some retired lines may be reused at higher realized salvage values.

EXHIBIT 15

ANALYSES OF ALTERNATE PLANS BASED ON PWAC

PLAN: II DESCRIPTION: Alpha, Common Control; Omega, Common Control

| YEAR STUDY | YEAR DEFERRED (n) | ACTIVITY | INSTALLED FIRST COST (IFC) | ANNUAL CHARGES FACTOR | $\left[(p/a)^{8\%}_{20} - (p/a)^{8\%}_{n}\right]$ | PRESENT WORTH OF ANNUAL CHARGES |
|---|---|---|---|---|---|---|
| | | **Alpha Exchg. (CC)** | | | | |
| 1977 | 0 | Install 900 Line Comm. Cont. Swbd. @ $250/Line | $225,000 | .212 | 9.818 | $468,319 |
| | 0 | Land Preparation | 2,000 | .150 | 9.818 | 2,945 |
| | 0 | New Bldg. | 45,000 | .173 | 9.818 | 76,433 |
| | 0 | S x S Retirement: $105,000 | - | .06* | 9.818 | (61,853) |
| | 0 | Salvage 550 Lines S x S @ $30/Line** | (16,500) | - | - | - |
| 1980 | 3 | Add 200 Line Comm. Cont. @ 290/Line | 58,000 | .212 | 7.241 | 89,035 |
| 1983 | 6 | Add 300 Line Comm. Cont. @ 335/Line | 100,000 | .212 | 5.195 | 110,685 |
| 1986 | 9 | Add 200 Line Comm. Cont. @ 388/Line | 77,600 | .212 | 3.571 | 58,747 |
| | | | $491,600 | | | $744,311 |
| | | **Omega Exchg. (CC)** | | | | |
| 1977 | 0 | Install 900 Line Comm. Cont. Swbd. @ $250/L | 225,000 | .212 | 9.818 | $468,319 |
| | 0 | Building Addition (28' x 30') | 45,000 | .173 | 9.818 | 76,433 |
| | 0 | S x S Retirement: $95,000 | - | .06* | 9.818 | 55,963 |
| | 0 | Salvage 500 Line S x S @ $30/Line** | (15,000) | - | - | - |
| 1981 | 4 | Add 200 L @ $304/Line | 60,800 | .212 | 6.506 | 83,860 |
| 1984 | 7 | Add 300 L @ $352/Line | 105,600 | .212 | 4.612 | 103,250 |
| 1987 | 10 | Add 200 L @ $407/Line | 81,400 | .212 | 3.108 | 53,634 |
| | | | $502,800 | | | $729,533 |

| | PW/AC | IFC |
|---|---|---|
| Alpha | $744,311 | $491,600 |
| Omega | 729,533 | 502,800 |
| | $1,473,844 | $994,400 |

*Maintenance and Property Tax saving
**Some lines may be reusable elsewhere in system

EXHIBIT 16

ANALYSES OF ALTERNATE PLANS BASED ON PWAC

PLAN: III DESCRIPTION: Alpha, Common Control; Omega, S x S Initially

| YEAR STUDY | YEAR DEFERRED (n) | ACTIVITY | INSTALLED FIRST COST (IFC) | ANNUAL CHARGES FACTOR | $[(p/a)^{8\%}_{20} - (p/a)^{8\%}_{n}]$ | PRESENT WORTH OF ANNUAL CHARGES |
|---|---|---|---|---|---|---|
| | | Alpha Exchg. (CC) | | | | |
| 1977 | 0 | Install 900 Line Comm. Cont. Swbd. @ $250/L | $225,000 | .212 | 9.818 | $468,319 |
| | 0 | Land Preparation | 2,000 | .150 | 9.818 | 2,945 |
| | 0 | New Bldg. | 45,000 | .173 | 9.818 | 76,433 |
| 1980 | 3 | Add 200 Lines @ $290/Line | 58,000 | .212 | 7.241 | 89,035 |
| 1983 | 6 | Add 300 Lines @ $335/Line | 100,500 | .212 | 5.195 | 110,685 |
| 1986 | 9 | Add 200 Lines @ $388/Line | 77,600 | .212 | 3.571 | 58,747 |
| | | | $508,100 | | | $806,164 |
| | | Omega Exchg. (S x S) | | | | |
| 1977 | 0 | Install Alpha Lines in Omega: 550 Lines @ $15/Line | $ 8,250 | .167 | 4.623* | $ 6,369 |
| | 0 | Building Addition (30' x 70') x $45/Sq. Ft. | 94,500 | .173 | 9.818 | 160,510 |
| | | (1650 AH C.O. Battery & 15 KW Engine Generator) | 18,500 | .212 | 9.818 | 38,506 |
| 1983 | 6 | Install 1400 Lines Comm. Cont. Swbd. @ $335L | 469,000 | .212 | 5.195 | 516,628 |
| | 6 | S x S Retirement: $200,000 (1050 Lines) | | .06 | 5.195 | (62,340) |
| | 6 | Salvage 1050 S x S Lines | | | | |
| 1987 | 10 | Add 200 Lines @ $407/Line | 81,400 | .212 | 3.108 | 53,634 |
| | | | $671,650 | | | $713,207 |

| | PW/AC | IFC |
|---|---|---|
| Alpha | $806,164 | $508,100 |
| Omega | 713,207 | 671,650 |
| Alpha + Omega | $1,519,271 | $1,179.750 |

*p/a for 6 years

EXHIBIT 17

ANALYSES OF ALTERNATE PLANS BASED ON PWAC

*U.S. GOVERNMENT PRINTING OFFICE : 1978 0-261-520-REA-309